MICROIRRIGATION IN IRAN- CURRENT STATUES AND FUTURE NEEDS

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ABSTRACT

In Iran, efforts were made to introduce microirrigation system (MIS) country wide around 1990. To promote, research effort have been made by research organization (AERI and SWRI), universities, ministry of Jahad-Agriculture, and state governments. The farmers level subsidy programme were undertaken by Ministry of Jahad-Agriculture. To tap its full potential, appropriate policies may be adopted through ensuring availability of standards materials, field-based research activities, evaluation of projects, solving the operational and maintenance problems. More attention is needed towards irrigation scheduling, system management, precise irrigation, potential advantages of MIS such as fertigation and automation, new technology such as subsurface drip irrigation. Research priorities are including crop water requirement, prevention of emitter clogging, fertigation and chemigation, precise irrigation, automation, soil-water-crop-climate relationship, subsurface drip irrigation, water and energy consumption, low pressure irrigation system, swage and saline water use and field evaluation of MIS.
Keywords: Iran, water resources, irrigation technology, microirrigation,

Summery And Conclusion

Water is rapidly becoming scarcer especially in arid and semiarid areas such as Iran. Available water resources remaining the same and growing population have resulted in competition for them form agriculture, domestic and industrial sectors, while irrigated agriculture is critical for national and world food security in these regions. The microirrigation system (MIS) is a versatile management tool which can increase productivity per unit volume of water and also save up to 50% water in addition to other savings in farm input costs. If MIS technology accepted worldwide scale can address the problem of water scarcity and equitable distribution squarely because it is neither location nor crop-specific. This paper attempts to review the experience in adoption of microirrigation technologies in Iran and outlines the major policy issues, which need to be addressed for their widespread adoption in developing countries.

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In Iran annual precipitation is about 252 mm; west, and southwest regions cover only 30% of the country's total area while receive around 56% of the total precipitation. It is while potential evaporation in Iran is 1500-2000 mm annually.
In Iran, efforts were made to introduce microirrigation system at farmer's level since 1990. It caused increase in yield up to 50% while saving water in a significant level. To promote research efforts have been made AERI, SWRI, INSRC, Ministry of Jahad-Agriculture and Universities. In Iran, the area under MIS is about 400,000 ha and estimating to be raised by 100% (800,000 ha) during next 5 years. The percentage of irrigated agricultural area in different provinces equipped to pressurized irrigation system (PIS) is varying between 2 to 38%. Due to the high initial cost, the farmers level subsidy programmer by Ministry of Jahad-Agriculture having a main role in this development. To tap its full potential, appropriate policies may be adopted through motivating the farmers, ensuring availability of standard materials, field-based research activities and solving the operational and maintenance problems. It is while, more attention is required towards integration of ferigation/chemigation, automation in irrigation and filtration, subsurface drip irrigation, precise irrigation management along with microirrigation system to harness full advantage of the system. We will discuss about MIS development in Iran during last two decades and available potential for development in different provinces, main consideration about water and land quality and practical experiences, the quality control for MIS especially on emitters, companies classifications, research priorities and valuable outcomes from research institutes, future development about subsurface drip irrigation and challenges in that regards.

Introduction

Increasing global population is projected to reach to 7.8 billion in 2025 (Cai and Rosegrant, 2003**)**. The growing population will result in considerable additional demand of food especially in developing countries where more than 80% of the population increase is expected to occur (Sekler et al., 1998). Simultaneously, water is rapidly becoming scared especially in arid and semiarid regions of CWANA (Central West Asia and North Africa Region), Arabian Peninsula, India and China. Moreover, the water demand from non-agricultural sectors in industry and households, as well as for environmental purposes will keep growing in both developed and developing countries. Irrigated agriculture has been an important contributor to the expansion of national and world food supplies since the 1960s and is expected to play a major role in future in feeding the growing world population. On the global scale, irrigated agricultural uses about 70% of the available fresh water resources (Cornish et al., 2004), which accounts for about 80% in arid and semiarid regions. With growing irrigated water demand and increasing competition across water-using sectors, the world now faces a challenge to produce more food with less water. This means that, even with the highest feasible efficiency and productivity of water use, these countries do not have sufficient water resources to meet their agricultural, domestic, industrial and environmental needs in 2025. Indeed, many of these countries cannot even meet their present needs.
In Iran annual precipitation is about 252 mm; west, and southwest regions cover only 30% of the country's total area while receive around 56% of the total precipitation. The central and eastern parts of the country which cover 70% of the country area only receive 44% of total country's precipitation (Dehghanisanij et al., 2006b). In Iran, where ground water is then the main water resources for agriculture, the number of wells has increased from 230,000 to 470,000 over last 10 years (Tamaab, 2004), while water table monitoring data showed water table declines of 0.12–1.79 meters per year depended on location in province.

Irrigation Efficiency

Based on the available data, the area that receives full irrigation in Iran is 2.5 Mha. Half of this area is equipped with modern systems of irrigation and networks is operated by government organizations. Irrigation efficiency in such systems is very low and is measured to be 20-30 percent. The reason for such low efficiency may be due to the free availability of water released from dams, giving no incentive to farmers to save water. The other half is operated by the private sector, and the water is supplied from groundwater resources. Here, also, the irrigation efficiency is rather low and has been measured to be about 35 percent. The rest of the irrigated farms in Iran belong to small farm holders who do not intentionally save water, but their irrigation efficiency is quite high. Irrigation efficiency in these farms is estimated to be 55-65 percent. The reason may be due to deficit irrigation, which they usually practice. These farmers have enough land, and the area under their cultivation is much greater than the water available to them. They usually get more benefit from extensive farming with deficit irrigation compared to intensive farming and full irrigation. Accordingly, any irrigation system could use water more efficiently, could improve productivity of water use and improve the food security Alizadeh and Keshavarz, 2005).

Irrigation Technology In Iran

Operationally, the technology that has been adopted for most of the new irrigation projects is not appropriate. It is true that the irrigation industry is not supposed to do original research and produce original technology. Rather, we look to the experience in other parts of the world and attempt to use good judgment and management, guided by the public interest, to transfer and apply the best available and most appropriate technologies (Alizadeh and Keshavarz, 2005).

If technology transfer does not take place with a view to provisions for future developments and to the characteristics of our societies, it is doomed to cause irreparable damage. Such problems are now seen in the modern irrigation projects that have been constructed in Iran during the past 20 to 30 years. Developing countries are suffering from the consequences of improper use of technology more than developed countries despite the fact that developing countries are expected to have learned from the experience in industrial countries.

Pressurized irrigation system (PIS) as a part of irrigation technology developed in Iran during last two decade rapidly, because of its advantages compared to traditional and surface irrigation system. Different type of PIS technology transferred to Iran by time and the level of related internal industry developed significantly during last two decade.

Microirrigation Development In Iran

Microirrigation because of its advantages on uniformity distribution, possibility of use in different topography, precise irrigation, improve in yield quantity and quality (Nakhjavani et al., 2008.), improve in water productivity, less labor, etc has developed in not only in the regions where water is scared but also in the regions where water in not limited yet.

PIS development in Iran during last two decade is presented in Figure 1. Accordingly, total area under PIS is more than 990,000 ha from which 40% is under microirrigation mostly including drip irrigation, subsurface drip irrigation and bubblers and the left sprinkle irrigation mostly including hand move system, gun system, center pivot and linear move. Before national development plan in Iran, the total area under MIS was about 50,000 ha.

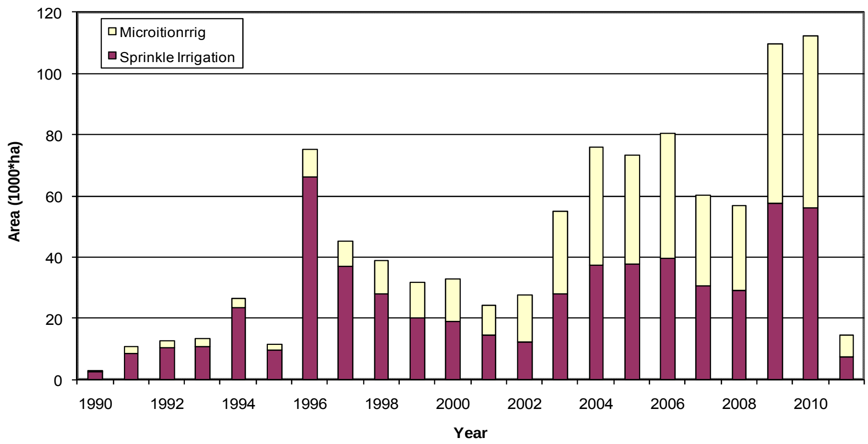

Figure 1. Pressurized irrigation (microirrigation and sprinkle) development in Iran.

Due to the high initial cost, the farmers level subsidy programmer by Ministry of Jahad-Agriculture having a main role in this development. The subsidy program changing by time and it caused different rate of development during 1990-2011. Besides, governmental support concentrated in some special years such as 1996 and 2009. Pressurized irrigation systems (PIS) development in Iran in early 1990's was mostly concentrated on sprinkle irrigation system (Figure 1). Late 90's, due to the drought and water scarcity in different part of the country, most of the orchard started to equipped to microirrigation systems. From year 2002, development of microirrigation and sprinkle irrigation are almost same along the country (Figure 1).

The percentage of total irrigated agricultural area equipped to PIS is not same in all agricultural regions of country. Its varying between states between 2% in South Khorasan located in east of country to 38% in Hormozgan located in south.

Recently, farmers use MIS for row crops widely in Iran. Accordingly, in some regions like Fars province in central part of Iran, farmers use MIS for row crop by their own cost just because of its beneficial; on lower labor cost, less water use, and better yield quality and quantity.

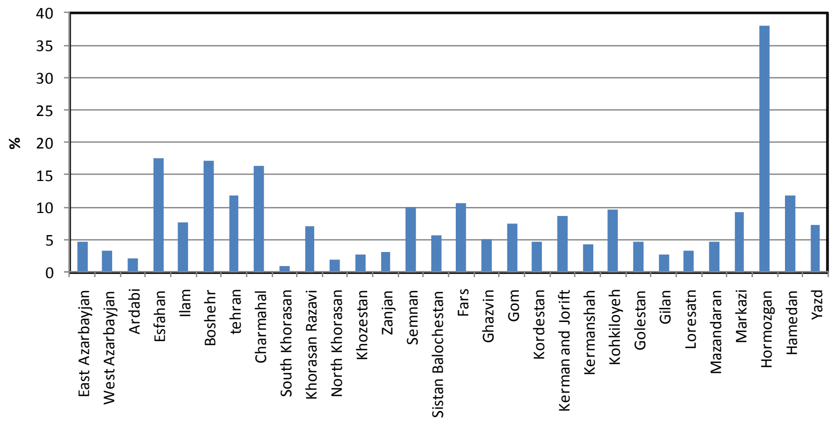

Figure 2. Percentage of irrigated area covered by pressurized irrigation system (PIS) in provinces of Iran.

About 2.5 million ha of fruits crops are grown in Iran, which are citrus, palm, apple, pistachio, etc. in different part of Iran, from which about 400,000 ha area under MIS. Microirrigation system provides a better water distribution especially in sandy soil, less water evaporation in warm regions, and less deep percolation compared to conventional irrigation methods. In arid and semiarid region like Iran the water quality usually is a limitation for MIS. I some part of Iran, MIS apply for pistachio tree using underground water with an EC of more than 10dS/m. Microirrigation system need careful maintenance to achieve the advantages of the system and prevent of emitter clogging (Dehghanisanij et al., 2006a).

Microirrigation system has become the system of choice in most part of Iran not only for fruit tress but also row crops such as maize, potato, sugar beet, and summer crops. Governmental subsidy could is very helpful in that regards. The potential benefits of applying MIS for are relatively small in term of water energy, but its adaptable because of economic, due to the labor, and quality and quantity of yield. One of the main advantages of DIS is minimizing nutrients; however fertigation has not applied in Iran.

Subsurface Drip Irrigation

After almost three decade of research and development on subsurface drip irrigation (SDI) internationally, most of its original problems such as root intrusion, plugging, fertility and lateral installation have been solved. SDI showed large increase in water and nitrogen use with concurrent increase in crop yield and quality. Prevention of ground water contamination with nitrates and salt and long-term economic sustainability have also been demonstrated. Since SDI is installed below the soil surface, a properly-managed system can increase the advantages of surface drip irrigation, especially in the area of water and nutrient conservation, salinity management, deep percolation, agricultural sustainability.

In Iran Subsurface irrigation using drippers started during last decade. A private company setup subsurface drip irrigation (SDI) in some small farm of citrus, olive, pistachio and landscape area since 2004. Agricultural Engineering Research Institute (AERI) in Iran started to work on using SDI for pistachio tress during 2005-10 using saline water, EC=8 dS/m (Eslami, 2011). According to the results of this study, the AERI recommended SDI for pistachio along the country. Because of water quality and lake of enough knowledge on design and management and operation of SDI in Iran, the governmental subsidy has not supported it for all the crops or fruit trees yet. The study on SDI application for maize, olive, citrus and palm are on-going in AERI.

Level Of Technology For Mis Industry

In Iran most part of a MIS including pipes (polymers and metals) in different sizes, connectors, valves, pumps and filtration systems produced. The quality of the products is controlling by Iranian universities, research institutes, and governmental organization. The quality control is based on Iranian standards as well as international standards such as ASABE, ISO and DIN. Currently more than 180 companies are producing equipment of pressurized irrigation system in Iran. The main limitation in producing irrigation equipment in Iran is emitters. Many kind of emitters had produced by Iranian companies but the quality of most of them have not approved yet.

Farmers and MIS technology

Since MIS technology is transferred to developing countries from outside, these countries can face more problems in providing the appropriate social changes to accompany technological developments than the industrial countries in which social development takes place simultaneously with technological development. A careful examination of the relationships between farmers and imported technology in modern irrigation projects of Iran reveals that when farmers have kept a safe distance from technology, they have maintained for themselves the right to choose an appropriate technology that enhances their goals. However, where this distance has disappeared, they have failed to exercise any control over their decisions, leaving them ultimately only the choice to either give up technology altogether or to follow not a progressive, but rather regressive path as dictated by technology.

There have been some cases in the past in which an irrigation project has been constructed with a modern system of water distribution. But when the project was given to local farmers, some feature of the project was changed by them, because the new system was not appropriate to them, negating some of the intended benefits of the project. To avoid such catastrophic choices, technology and its relevance to each particular situation must be studied and then an appropriate form of technology must be introduced.

On-Going Research On Mis

Research on MIS is being carried out in various states by research organization and universities. Pressurized Irrigation Research Department of AERI is the main responsible organization for any questions on PIS in Iran. Their activities are totally about the issues of PIS. The scope of research in AERI covers all the issues related to PIS depended to each province/state; comparative performance evaluation of surface and subsurface drip irrigation (Dehghanisanij and Akbari, 2006), sprinkle and conventional methods under soil profiles and agro climate, saline water use, crop response, MIS layout, soil moisture distribution pattern, irrigation scheduling, emitter clogging, filtration, automation, precise irrigation (Dehghanisanij and Akbari, 2008).

Drip Irrigation System Evaluation

Evaluation are performed in different irrigation projects to determine the emission uniformity (E_U) of each system, irrigation management, system maintenance. In most of the project evaluation; type of emitters, emitter clogging, filtration system design, and irrigation scheduling, were the main issues.

The coefficient of manufacturing variation (V_m) of Emitters usually was not in acceptable range and caused low E_U at on-farm level. Most of the farmers applied irrigation water based than their experience rather than irrigation scheduling recommended by designer of MIS. It is while, irrigation scheduling recommended by designer of MIS mostly were based on long term wheatear climate information, not actual condition at farm level. Sometimes long distance of weather station from the farm decreased the reality of irrigation scheduling as well.

Dehghanisanij et al. (2002) investigated the impact of selected water quality attributes (chemical), the duration of the irrigation system in use (long and short period), and the pressure head distribution in the irrigation system on uniformity of water distribution in irrigation systems. Field experiments were conducted in eleven farms, equipped with microirrigation system, in Southeast Iran. The field performance indices, mean discharge ratio of emitters (D_{ra}) and coefficient of variation of emitter discharge (V_{pf}) seems to be more sensitive and reliable, for assessing the severity of clogging, than uniformity coefficient (U_c) or emission uniformity coefficient (E_u). Emission uniformity coefficient in the irrigation systems in operation for short period was higher, E_u>80%, than those in operation for long period, E_u<66%.

Dehghanisanij et al. (2002) showed that in irrigation systems which were in use for long period, the values of water distribution uniformity were in the unacceptable category (<66%). The U_c and E_u were low and V_{pf} high, exclusive of the irrigation system No. 6, for which the indices were moderate. The V_{pf} values were sensitive to degree of clogging in the irrigation systems. Theoretically, if the working pressure of the irrigation systems were different from designed pressure, then V_{pf} would reduce the effects of pressure variation on emitter discharge (Figure 3.).

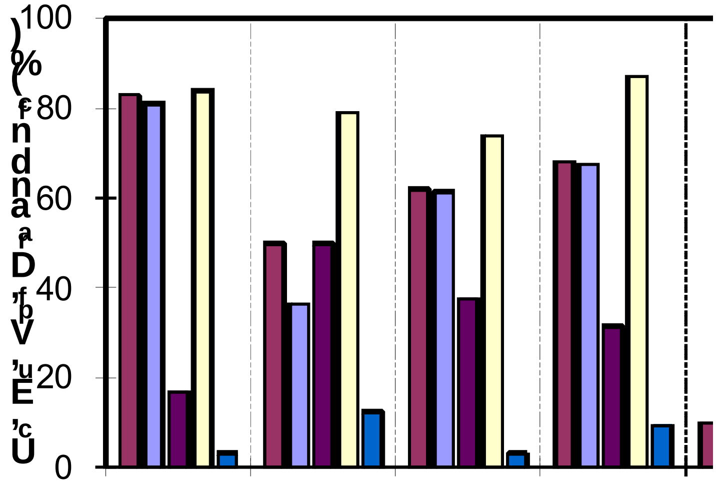

Figure 3. Irrigation systems performance indices for long operation period.

Based on the evaluation study of PIS under operation, some of items are needed to be considered for sustainable development PIS in Iran, some of them are;

1. Consideration of soil, water and climatologically condition in PIS selection
2. Improvement of designer and installer of PIS
3. Economical beneficial of PIS for farmers
4. Cost of PIS and supporting system by the government
5. Evaluation of PIS under operations and using the results for future projects development
6. Cooperation of users in design and installation of PIS
7. Short time support of user in operation of PIS
8. Quality of equipment, installation and operation in PIS

Clogging Of Emitters

Different study has been conducted on potential of emitter clogging in different part of country. Dehghanisanij et al. (2007) evaluated the potential of emitter clogging on six types of emitters (table 1). Firstly, a laboratory tests were performed on new emitters to quantify the manufacturing associated variations in emitter performance by determining the manufacturing coefficient of variation (Vm). Six types of emitters differing in nominal discharge (q_n), orifice area (OA), pressure compensating and non-pressure compensating system were used in this study (Table 1).

Table 1. Some characteristics of the emitters used for the study; nominal discharge (q_n), orifice area (OA), emitter discharge coefficient (k), the emitter discharge exponent (x) and manufacturing coefficient of variation (Vm).

Lateral No.	Type of emitter	Nominal discharge (q_n)* L h^{-1}	Orifice area (*OA*)* mm^2	*k*	*x*	*Vm* %	Other characteristics*
EM1	In-line	4.0	1.60	1.265	0.51	10	Turbulent labyrinth, large labyrinth
EM2	On-line	8.0	2.25	2.240	0.45	5	Turbulent labyrinth
EM3	On-line	3.0	1.45	1.911	0.02	4	Pressure compensating, anti-
EM4	On-line	5.0	1.85	1.205	0.03	7	Turbulence, pressure compensating, self-
EM5	On-line	4.0	1.80	0.617	0.44	11	Turbulence, self-flushing,
EM6	On-line	2.0	1.10	0.393	0.45	11	Turbulent labyrinth

* According to the manufacture's manual.

Flow rate reduction in the laterals which irrigated at night (S2) was less than that irrigated at day time (S1). For example: accumulated lateral flow rate after one month on July 4 for EM1 was 14.42 and 22.65 for S1 and S2, respectively. Moreover, the differences in flow rate reduction in laterals between S1 and S2 treatments were affected by emitter characteristics such as nominal discharge rate and orifice size area (Figs. 4). The differences were higher in emitters with lower nominal discharge and orifice size, and vise versa. For example, 15 days after irrigation, the difference between the accumulated lateral flow rate in EM2 with nominal discharge rate and orifice size of 8 L h^{-1} and 2.25 mm^2, respectively, was 6.86 m^3, while it was 9.01 m^3 in EM6 with the lowest nominal discharge rate (2 L h^{-1}) and orifice area (1.10 mm^2). Accordingly, they concluded that under saline water use, irrigation at night time can control chemical clogging in emitters, especially, when emitters with low nominal discharge (< 3 Lh^{-1}) is used.

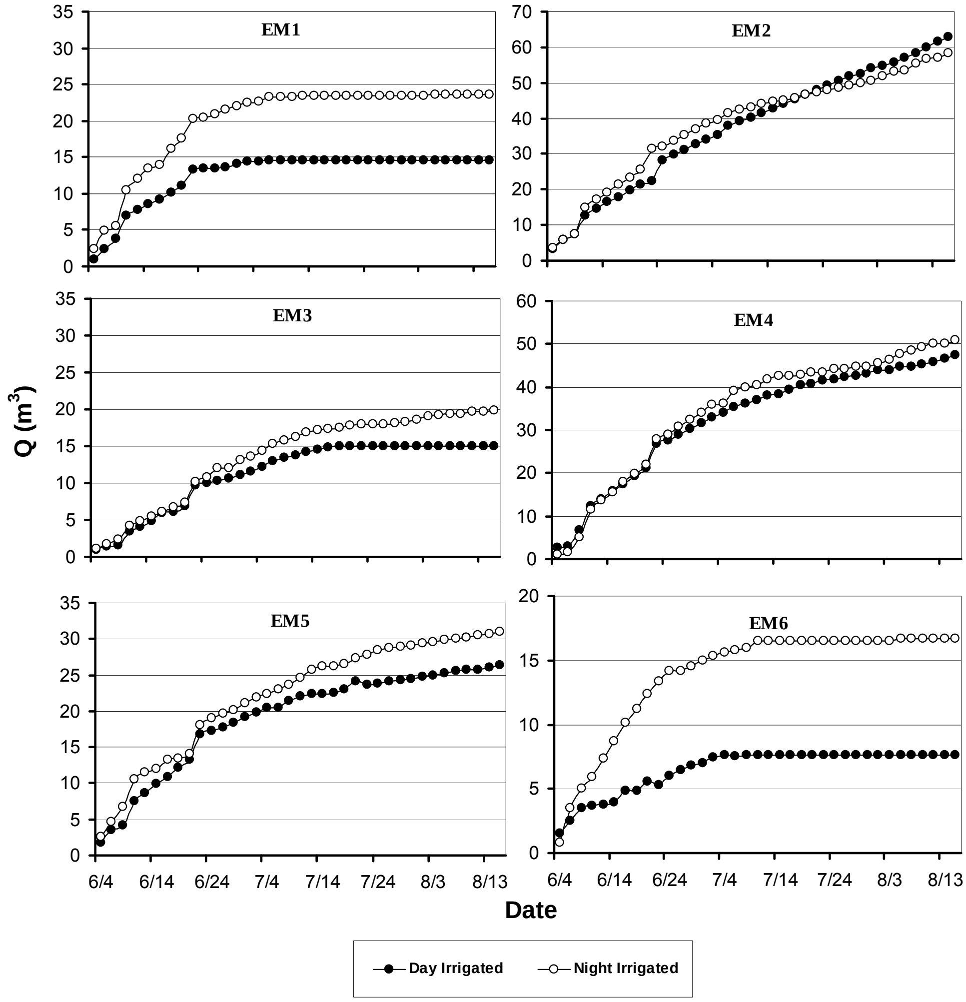

Figure 4. Variations in the accumulated laterals flow rate for the different emitter types (EM) under day and night irrigation schemes.

FUTURE PERSPECTIVE OF MIS IN IRAN

To tap the full potential of MIS with a sustainable manner, appropriate policies for governmental support may be adopted (Dehghanisanij 2008). The major steps that may be taken to popularize the MIS are:

- Motivation to all potential farmers for adoption of MIS to save irrigation water and increase productivity of their farm.
- Promote knowledge of designers and installer of MIS.
- Supply of standard material that may confirmed to the Iranian standard.
- Promote customer services for maintenance and supply of adequate spares by manufactures, their agent and local entrepreneurs.
- Development of skills and confidence among the farmers to properly use MIS.

- Continues research studies on different MIS applied to different crops, soils, soil and water conditions, etc to find out their satisfactory solution.

RESEARCH NEEDS

After almost two decade of development of MIS, still many areas of design, adoption, operation and management of MIS need further study and research for different crops, soils, soil and water conditions, etc (Dehghanisanij, 2008). some of main topics listed as follows;

- Crop water requirement; it is essential to prepare technology to measure daily water requirement at farm level considering crop. Age of crop, season and soil.
- Prevention of emitter clogging; appropriate filters, maintenance, emitter selection, water treatment, etc.
- Fertigation and chemigation; methods and scheduling
- Precise irrigation; automation, uniformity distribution, soil-water-crop-climate relationship.
- Subsurface drip irrigation; root system development and prevention of root intrusion.
- Water and energy consumption; low pressure irrigation system
- Swage and saline water use in MIS
- Field evaluation of MIS under operation

CONCLUSIONS

The microirrigation system (MIS) is becoming more and more popular in India, due to its advantages compared to other irrigation system which may have positive impact on crop yield and quality. To enhance the area under MIS, support of governmental agencies, research institution and private companies and factory were very important. The efforts are being made in all the levels. The country likes Iran where MIS has transferred, should concentrate more toward developing the adaptive research approach at on-farm level as pilot. Future research is need considering sustainable development of MIS. Soil and water quality and quantity and climatologically condition must be studied precisely for MIS and different crops. Subsurface drip irrigation is new in Iran and all the question about surface drip irrigation must be studied for SDI as well. The technology of microirrigation has to play a vital role in irrigation of orchard and row crops in near future, hence greater attention maybe provided to develop the skill and know-how about the system, chemicals, automation, precise irrigation and other equipments required by the users time to time.

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